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(71) Applicant: SHARP KABUSHIKI KAISHA
22-22 Nagaike-cho Abeno-ku
Osaka 545(JP)

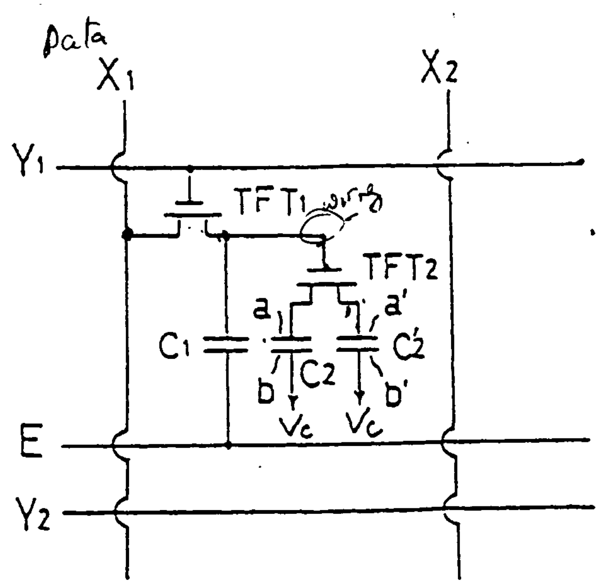
(72) Inventor: Hamada, Hiroshi
7-177, Aoyama
Nara-shi, Nara-ken(JP)
Inventor: Funada, Fumiaki
33-10, Izumihara-cho
Yamatokoriyama-shi, Nara-ken(JP)

(74) Representative: Brown, Kenneth Richard et al
R.G.C. Jenkins & Co. 26 Caxton Street
London SW1H 0RJ(GB)

(54) A liquid crystal display apparatus.

(57) A liquid crystal display apparatus which stores a charge in the capacitor whereby the liquid crystal layer is continuously driven even if leak occurs therethrough, and which prevents any d.c. component from being applied to the liquid crystal layer, thus maintaining a display of clear, non-flickering constant image on the screen.

Fig. 1



EP 0 414 478 A1

A LIQUID CRYSTAL DISPLAY APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the invention:

The present invention relates generally to a liquid crystal display apparatus, and more particularly to an active matrix type liquid crystal display apparatus adapted for use in the precision finders of cameras and projection type televisions.

2. Description of the back ground of the invention:

It is known in the art that a matrix type liquid crystal display apparatus is used to utilize the electrooptical effects of liquid crystal to modulate an incident light to picture elements and make up a TV picture and the like. This type of display apparatus includes a liquid crystal layer between two electrodes, that is, a plurality of picture element electrodes arranged in a dot-matrix, and counter electrodes corresponding to the picture element electrodes, wherein the liquid crystal layer optically modulates an incident light in response to an applied voltage.

The matrix type liquid crystal display apparatus, hereinafter referred to as "display apparatus", can take various modes depending upon the kinds of the liquid crystal to be used or the electrooptical properties thereof; for example, a twisted nematic (TN) mode, a super twisted nematic (STN) mode, a guest and host (GH) mode, a dynamic scattering (DS) mode, a phase transition mode, and any other suitable mode can be appropriately selected. The display picture elements consisting of the liquid crystal and the picture element electrodes are individually controlled by various methods, for example:

(1) A simple-matrix method;

(2) A method using a non-linear two-terminal device (e.g., a diode) added to each picture element electrode; and

(3) A method using a switching three-terminal device (e.g., thin film transistor (TFT)) added to each picture element electrode.

The methods (2) and (3) are generally called an active matrix system.

The DS mode (Proc IEEE 56 1162 (1968) by G.H. Heilmeier et al), a White Taylor type GH mode (J. Appl. Phys. 45 4718 (1974) by D.L. White et al), and a cholesteric nematic phase transition mode (Proc. SID 13/2 115 (1980) by J.J. Wysocki) are advantageous when they are used in association with an active matrix system using TFT, in that the display brightness is enhanced without the use of a polarizer.

However, this display apparatus has a problem that the addition of a dichroic dye which contains ionizable impurities increases the specific electric conductivity of the liquid crystal layer. As a result, the charge stored in the electrodes between which the liquid crystal layer is sandwiched easily leaks through the liquid crystal layer. To solve this problem, as shown in Figure 8 a signal voltage storing capacitor C_1 (i. e., an additional capacitor) is provided in parallel with a picture element capacitor C_2 connected to a drain electrode of the TFT, so as to increase the capacity of the capacitor C_1. In this way the electric charge is maintained.

However, the method using the signal voltage storing capacitor C_1 basically has a limitation in maintaining the charge, and in order to drive a highly integrated matrix display apparatus having many capacitors C_1 of sufficient capacitor, the source driver and the switching TFT must supply a very large current, and the resistance of the source bus line must be very low. In addition, the space for accommodating picture element electrodes is accordingly reduced, and manufacturing difficulty is involved.

Figure 9 shows an example which drives an equivalent circuit in a similar manner to the present invention. That is, an active matrix type liquid crystal display apparatus. The apparatus is provided with picture elements each of which comprises two capacitors C_2 and a three-terminal element such as TFT, wherein the picture elements and the TFT are arranged in a matrix ("Japan Display Digest", page 80 to 83).

In this display apparatus the pairs of picture element electrodes are connected to the source and drain of each TFT and counter electrodes T_R and T_D corresponding to the respective picture element electrodes. The electrodes T_R are connected to a reference electrode line R, and the electrode T_D is connected to the data electrode line D. The reference line R is earthed or maintained at a constant level of voltage, and the data electrode line D is applied with a signal voltage in accordance with the information to be displayed. Under this arrangement, when the gate voltage is at a high level, the TFT is on, thereby forming a closed circuit starting from the data electrode line D, the liquid crystal layer, the first picture element electrode, the TFT, the second picture element electrode, the liquid crystal layer, and ending at the reference electrode line R. As long as the gate voltage is at a high level, the capacitors C_2 and C'_2

are charged. However, this charge does not last, and gradually discharge through the liquid crystal layer and switching three-terminal element when the TFT is off. In order to maintain the charge in the capacitors sufficient to drive the liquid crystal properly, it is required to prepare liquid crystal having an extremely high specific resistance.

To solve the problem pointed out above, the inventors have made an invention shown in Figure 7, for which Japanese Patent Application No. 1-95581 is pending. According to the prior application, the signal voltage storing capacitor C_1 is separated from the picture element capacitor C_2 by the TFT_2. The TFT_1 and the capacitor C_1 function as a sampling/holding circuit. While the TFT_1 is on, the capacitor C_1 is charged with the signal voltage through the drain of the TFT_1, and after the TFT_1 is off, the capacitor C_1 keeps the signal voltage being applied to the gate of the TFT_2 until the next signal voltage is sampled through the drain. The advantage of this method of Figure 7 is that even if the liquid crystal has a small specific resistance, the display is protected against an unfavorable influence of discharge in the liquid crystal. However, when the halftone image is to be displayed, a problem arises. In Figure 7, suppose that the capacitor C_2 is not charged, that is, the picture element "a" and the counter electrode "b" are at an equal potential, and that the capacitor C_1 is negatively charged. In this situation, the gate potential of the TFT_2 is kept negative, the TFT_2 is off, and the picture element electrode "a" is electrically isolated from the earth line. At this stage, an a.c. voltage V_C is applied to the counter electrodes, the potential of the picture element electrode a changes accordingly.

Then, when the capacitor C_1 is positively charged, the TFT_2 is on. The capacitor C_2 is charged at a time constant $\tau_{ON} = C_2 R_{ON}$. At this stage, the potential of the picture element electrode a has the same polarity as V_C, and gradually becomes equal to the earth potential. When the halftone image is to be displayed, it is required to repeat the polar reversion of the voltage V_C in a shorter period of time than the period of time required for the completely charging of the capacitor C_2.

However, the polar reversion of voltage V_C changes the potential of the drain, thereby changing the "on" resistance R_{ON} of TFT_2. Even if the positive/negative symmetrical a.c. voltage is applied as the voltage V_C, the operating point of the TFT_2 changes unavoidably changes with time, thereby causing the "on" resistance R_{ON} to have different values between the positive half-cycle and the negative half-cycle. Thus, the potentials of the picture element electrode "a" and the counter electrode "b" are non-symmetrical for negative and positive, thereby bringing a direct current component into the voltage applied to the liquid crystal layer of the capacitor C_2. This d.c. component causes a flickering in the pictures on the screen.

When the liquid crystal layer has a d.c. component, the liquid crystal and electrodes are liable to electrolysis. This is detrimental to the formation of clear image.

SUMMARY OF THE INVENTION

The liquid crystal display apparatus of the present invention, which overcomes the above-discussed and numerous other disadvantages and deficiencies of the known art, comprises a plurality of unit circuit areas formed with electrode lines X and Y crossing each other in an electrically isolated state, each unit circuit area comprising a pair of picture element electrodes and a pair of counter electrodes, a first switching three-terminal element having a source connected to the line X and a gate connected to the line Y near the crossover of the lines X and Y, a liquid crystal layer being disposed between the picture element electrodes and counter electrodes, a second switching three-terminal element having its gate connected to the drain of the first switching three-terminal element, and having its source and drain connected to the picture element electrodes, a signal storing capacitor being disposed between either of the earth line or the adjacent line Y and the drain of the first switching three-terminal element, and an a.c. voltage source for delivering an a.c. voltage to the counter electrodes.

In a preferred embodiment, each of the counter electrodes in one unit circuit area is electrically connected to the corresponding counter electrode in the adjacent unit circuit area.

In a further preferred embodiment, the specific resistance of the liquid crystal is not greater than 10^9 Ωm within the effective range of temperatures at which the liquid crystal display apparatus is operable.

In a still further preferred embodiment, the a.c. voltage source delivers a positive/negative symmetrical a.c. voltage having reversed phases in each one cycle.

According to another aspect of the present invention, the liquid crystal display apparatus liquid crystal display apparatus comprising a plurality of unit circuit areas formed with electrode lines X and Y crossing each other in an electrically isolated state, each unit circuit area comprising a pair of picture element electrodes and a pair of counter electrodes, a first switching three-terminal element having a source connected to the line X and a gate

connected to the line Y near the crossover of the lines X and Y, a liquid crystal layer being disposed between the picture element electrodes and the counter electrodes, a common line for delivery of an a.c. voltage having an opposite phase to that of the a.c. voltage, a liquid crystal layer being disposed between the picture element electrode and the counter electrode, a second switching three-terminal element having its gate connected to the drain of the first switching three-terminal element, and having its source and drain connected to the picture element electrode and the common line, and a signal storing capacitor formed between either of the earth line or the adjacent line Y and the drain of the first switching three-terminal element.

In a preferred embodiment, a dummy load is additionally inserted between the source of the second switching three-terminal element and the common line, the dummy load having an impedance approximately equal to that of the liquid crystal.

The electrode lines X and Y are selected by scanning at a short frame frequency, so that the first switching three-terminal element is made in the "on" state for a relative short period of time. However, owing to the charge stored in the storing capacitor the voltage is continuously applied to the gate of the second switching three-terminal element until the next signal is sampled, thereby maintaining the second three-terminal element in the "on" state. Since the charge stored in the storing capacitor is separated from the liquid crystal layer by means of the second switching three-terminal element, the charge is prevented from leaking which would otherwise occur through the liquid crystal layer. Thus, the charge is held for a longer period of time. This is important for maintaining a display of clear and non-flickering constant image on the screen.

On the other hand, so long as the second switching three-terminal element is kept on, no unfavorable influence is given on the image on the screen because the charge is continuously delivered to drive the liquid crystal layer even if any leak occurs in the layer. In this case, even if the liquid crystal layer is made of a substance having a small specific resistance, the display is maintained for one frame frequency.

When a positive and negative symmetrical (per one cycle) and an opposite phase voltage is applied between the counter electrode and the common electrode or alternatively a positive and negative symmetrical (per one cycle) voltage is applied to between the pair of counter electrodes, a virtually perfect positive and negative symmetrical voltage is applied to the liquid crystal layer through the second three-terminal element channel, thereby preventing any d.c. component from being applied thereto. It ensures that no flickering occurs in the image on the screen.

Thus, the invention described herein makes possible the objectives of providing a liquid crystal display apparatus (1) which prevents any d.c. component from being unexpectedly applied to the liquid crystal layer, and (2) which can display halftone images as clearly as any other tone images.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawings as follows:

Figure 1 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a liquid crystal display apparatus according to the present invention;

Figure 2 is a schematic plan view of the unit circuit area portion of Figure 1 showing the positional relationship between the picture element electrodes and the counter electrodes;

Figure 3 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a first example of the embodiment;

Figure 4 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a second example of the embodiment;

Figure 5 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a third example of the embodiment;

Figure 6 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a fourth example of the embodiment;

Figure 7 is a circuit diagram showing a unit circuit area of an equivalent circuit used in a liquid crystal display apparatus made prior to the present invention; and

Figures 8 and 9 are circuit diagrams showing unit circuit areas of equivalent circuits used in a known liquid crystal display apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, an example (1) of the embodiment according to the present invention will be described:

Figure 1 shows a unit circuit area of a circuit incorporated in the display apparatus of the present invention. Each unit circuit area is framed by electrode lines X and Y. The unit circuit area has a pair of picture element electrodes and a pair of counter

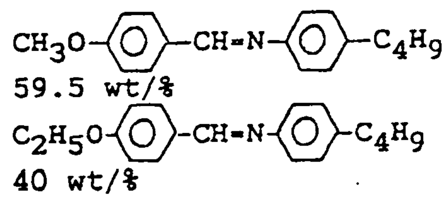
electrodes. A voltage is output by a drain of a first switching three-terminal element that is selected in accordance with electrode line X and Y, thereby storing a charge in a signal voltage storing capacitor, and applying it to a gate of a second switching three-terminal element. Voltage is applied to the unit circuit area whereby the picture element electrodes are energized. By the application of this voltage, a closed circuit is completed from one of the counter electrode "b", the liquid crystal layer "C_2", one of the picture element electrodes "a", the TFT_2 (i.e., from the source to the drain of the second switching three-terminal element), the other picture element electrode "a'", the crystal liquid layer "C'_2", and the other counter electrode "b'". The picture element electrodes display when the liquid crystal layer is driven by the application of an a.c. voltage.

Referring to Figures 1 and 2, the electrode lines X_1, X_2 and so on are bus lines for data signals, and the lines Y_1, Y_2 and so on are also bus lines for scanning signals. These electrode lines X and Y are crossed in an electrically isolated state, that is, with the interposition of insulating films, hereinafter referred to as "crossover". A first TFT_1 is located adjacent to one of the crossover whose gate is connected to the line Y (Y_1) and whose source is connected to the line X (X_1). The drain of the TFT_1 is connected to the gate of a second TFT_2 that functions as a second three-terminal element. The TFT_2 is connected to a signal storing capacitor C_1 whose other electrode is earthed.

Referring to Figure 2, the source and drain of the second TFT_2 are connected to a pair of picture element electrodes "a" and "a'". Each pair of picture element electrodes have a pair of counter electrodes "b" and "b'". A liquid crystal layer is disposed between the picture element electrodes and the counter electrode so as to form picture element capacities C_2 and C'_2. An a.c. voltage source V_C delivers a.c. voltage to the liquid crystal layer.

By adopting the circuit mentioned above, a mode projection type active matrix liquid crystal display apparatus (hereinafter referred to as "display apparatus") was constructed:

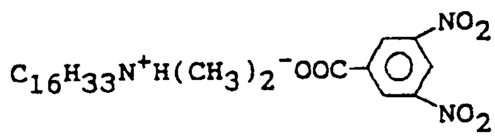
(1) Method of display: projection type
(2) Light source: metalhalide lamp
(3) Size of panel: 3 inches (diagonal)
(4) Number of picture elements: 240 X 384 dots
(5) Substrate of panel: glass 1.1t Corning 7059
(6) TFT_1, TFT_2: amorphous silicon TFT
Gate made of Ta, oxidized film Ta_2O_5/SiN_x semiconductor made of a-Si by P-CVD source, drain made of n^+ a-Si/Ti
(7) Capacitor C_1: Ta/Ta_2O_5 SiN_x/Ti
(8) Capacitor C_2: ITO/liquid crystal layer/ITO (thickness of liquid crystal was set by a plastic-bead spacer of 7 µm
(9) Liquid crystal layer:



59.5 wt/%

40 wt/%

The following ionizing impurities were added:
(10) Ionized impurities:



(0.5 wt/%)

(11) A.C.voltage: 60Hz (rectangular waveform) ±7.5V
(Note) The liquid crystal layer has a specific resistance (ρ) of 10^{17} Ωm.

The TFT_1 and the capacitor C_1 constitute a sampling/holding circuit, whose output is connected to the gate of the TFT_2 that functions as a buffer transistor for applying an a.c. voltage to the liquid crystal layer in the liquid crystal layer.

Under the arrangement mentioned above, the capacitor C_1 is connected not directly to the capacitors C_2 and C'_2 but to the gate of the second TFT_2 having high input impedance, thereby making it difficult to discharge. As a result, the charge stored in the capacitor C_1 keeps the TFT_2 on for a relative long period of time even after the TFT_1 is off.

This is of particular advantage when the used liquid crystal is of a type which is easy to discharge because of its small specific resistance. In this way, the TFT_2 is prevented from becoming off before a required period of time (usually, 1 cycle of the frame frequency) expires, thereby ensuring that the display apparatus continues to display for a desired period of time.

The a.c. voltage source V_C applies an a.c. voltage between the pair of electrodes "b" and "b'". The application of a symmetrical a.c. voltage enables the capacitors C_2 and C'_2 to behave symmetrically in response to the polar changes of the voltage from the power source V_C for driving the liquid crystal layer.

The illustrated apparatus takes an inter-digital form in which stripe electrodes "b" and "b'" are disposed in alternate rows along the lines X or Y depending upon the arrangement of pairs of picture

element electrodes a_{11} and a'_{11}, a_{12} and a'_{12} and so on.

Figure 2 shows an arrangement in which a pair of picture element electrodes a_{11} and a'_{11}, a_{12} and a'_{12} are laterally disposed, and the counter electrodes of a stripe type are vertically disposed. However, the lateral and vertical directions of them can be changed as a matter of design. A single stripe electrode is disposed in such a manner that it covers one of the picture element electrodes and one of the adjacent picture element electrodes.

The apparatus was experimentally operated to display on a screen, and the resulting image thereon was compared with that obtained by a conventional TN mode apparatus with the use of the same light source. The result was that the luminance was about two times (i.e., 100 fL) that of the image under the known apparatus under the display in white.

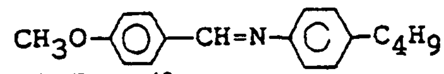
Referring to Figure 3, an example (2) will be described:

This example is different from the first example in that one of the electrodes of the capacitor C_1 is connected to the adjacent gate line. The advantage of this example is that the earth line can be omitted.

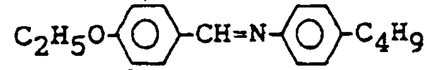
Referring to Figure 4, an example (3) will be described:

Basically the circuit has the same construction as that of the first example shown in Figure 1 but it is different therefrom in that one picture element has a single picture element electrode "a", and that the source of the TFT_2, that is, the second switching three-terminal element is connected to the common line F to which an a.c. voltage is applied from a source V_C' to drive the liquid crystal. By adopting this circuit, a DS mode display apparatus having no polarizing filter was constructed:

(1) Method of display: projection type
(2) Light source: metalhalide lamp
(3) Size of panel: 3 inches (diagonal)
(4) Number of picture elements: 240 X 384 dots
(5) Substrate of panel: glass 1.1t Corning 7059
(6) TFT_1, TFT_2: amorphous silicon TFT Gate made of Ta, oxidized film Ta_2O_5/SiN_x semiconductor made of a-Si by P-CVD source, drain made of n^+ a-Si/Ti
(7) Capacitor C_1: $Ta/Ta_2O_5 . SiN_x/Ti$
(8) Capacitor C_2: ITO/liquid crystal layer/ITO (thickness of liquid crystal was set by a plastic-bead spacer of 7 µm)
(9) Liquid crystal layer:

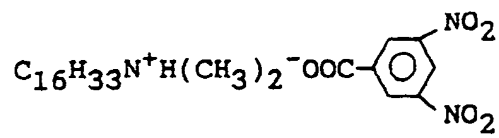


59.5 wt/%



40 wt/%

The following ionizing impurities were added:
(10) Ionized impurities:



(0.5 wt/%)

(11)A.C. voltage: 60Hz (rectangular waveform) ±7.5V
(Note) The liquid crystal layer has specific resistance of 10^7 Ωm. The area (S) of the picture element was 100 $\mu m^2 (10^{-8} m^2)$, and the thickness (d) of the liquid crystal was 7 µm.
Therefore, the resistance (R_{LC}) was $(\rho \cdot d)/S = 7 \times 10^9$ Ω.

In this example (3) the TFT_1 and capacitor C_1 also function as a sample holding circuit. Therefore, after the TFT_1 was off, the TFT_2 remains on for a longer period of time.

A reversed-phase a.c. voltage is applied to the common line F from the source V_C', the reversed-phase a.c. voltage having the same frequency as that of the voltage applied to the electrodes "b" from the other source V_C. In this way the TFT_2 behaves symmetrically when the source V_C is positive and negative.

This version was experimentally operated to display on a screen, and the resulting image thereon was compared with that obtained by a conventional TN mode apparatus with the use of the same light source. The result was that the luminance was about two times (i.e., 100 fL) that of the image under the known apparatus under the display in white.

Referring to Figure 5, an example (4) will be described:

This example (4) is different from example (3) of Figure 4, in that one of the electrodes in the capacitor C_1 is connected to the electrode lines Y_2 adjacent thereto, thereby omitting the earth line.

Referring to Figure 6, there is provided an example (5) characterized in that a dummy load Z_0 is inserted the common line and the drain of the TFT_2. The dummy load, for example, is provided by interposing a non-doped a-Si film (film thickness d=28nm, specific resistance ρ = 10^8 Ωm) between

the drain of the TFT_2 and the common line. The overlapping area is 20 μm^2, and therefore, the dummy load Z_D has a resistance R' of 7×10^9 Ω, which is equal to the resistance R_{LC} of the liquid crystal. The feature of this example (5) is that the dummy load having the same resistance as that of the liquid crystal is inserted between the drain electrode and the common line, thereby enabling an applied voltage to operate the display apparatus in the same manner irrespective of whether it is negative or positive. As a result, no flickering was discerned.

It is understood that various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be construed as encompassing all the features of patentable novelty that reside in the present invention, including all features that would be treated as equivalents thereof by those skilled in the art to which this invention pertains.

Claims

1. A liquid crystal display apparatus comprising a plurality of unit circuit areas formed with electrode lines X and Y crossing each other in an electrically isolated state, each unit circuit area comprising a pair of picture element electrodes and a pair of counter electrodes, a first switching three-terminal element having a source connected to the line X and a gate connected to the line Y near the crossover of the lines X and Y, a liquid crystal layer being disposed between the picture element electrodes and counter electrodes, a second switching three-terminal element having its gate connected to the drain of the first switching three-terminal element, and having its source and drain connected to the picture element electrodes, a signal storing capacitor being disposed between either of the earth line or the adjacent line Y and the drain of the first switching three-terminal element, and an a.c. voltage source for delivering an a.c. voltage to the counter electrodes.

2. A liquid crystal display apparatus according to claim 1, wherein each of the counter electrodes in one unit circuit area is electrically connected to the corresponding counter electrode in the adjacent unit circuit area.

3. A liquid crystal display apparatus according to claim 1, wherein the specific resistance of the liquid crystal is not greater than 10^9 Ωm within the effective range of temperatures at which the liquid crystal display apparatus is operable.

4. A liquid crystal display apparatus according to claim 1, wherein the a.c. voltage source delivers a positive/negative symmetrical a.c. voltage having reversed phases in each one cycle.

5. A liquid crystal display apparatus comprising a plurality of unit circuit areas formed with electrode lines X and Y crossing each other in an electrically isolated state, each unit circuit area comprising a pair of picture element electrodes and a pair of counter electrodes, a first switching three-terminal element having a source connected to the line X and a gate connected to the line Y near the crossover of the lines X and Y, a liquid crystal layer being disposed between the picture element electrodes and the counter electrodes, a common line for delivery of an a.c. voltage having an opposite phase to that of the a.c. voltage, a liquid crystal layer being disposed between the picture element electrode and the counter electrode, a second switching three-terminal element having its gate connected to the drain of the first switching three-terminal element, and having its source and drain connected to the picture element electrode and the common line, and a signal storing capacitor formed between either of the earth line or the adjacent line Y and the drain of the first switching three-terminal element.

6. A liquid crystal display apparatus according to claim 5, which further comprises a dummy load inserted between the source of the second switching three-terminal element and the common line, the dummy load having an impedance approximately equal to that of the liquid crystal.

7. A liquid crystal matrix display apparatus wherein a matrix array of pixel display areas are controlled by signals applied to X and Y electrode lines and wherein for each said pixel display area there is provided a display circuit comprising display electrode means, counter electrode means, a first switch element havong a source electrode connected to a said Y line and a gate electrode connected to a said X line, a second switch element havong a gate electrode connected to the drain of the first switch element and having its source and drain connected in series in an energising circuit including the picture element and counter electrodes, a liquid crystal layer therebetween, and an AC voltage source for delivering an AC voltage such that the voltage across said liquid crystal layer alternates symmetrically, a signal storing capacitor being connected to the drain of the first switch element to hold the control signal applied to the gate electrode of the second switch element.

Fig. 1

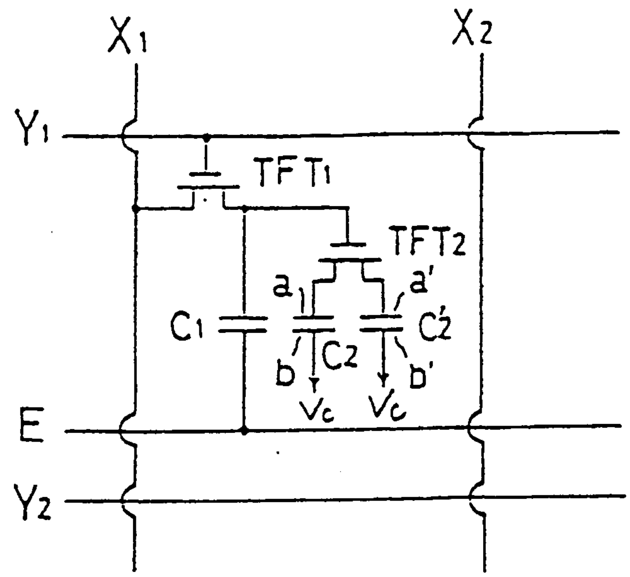


Fig. 3

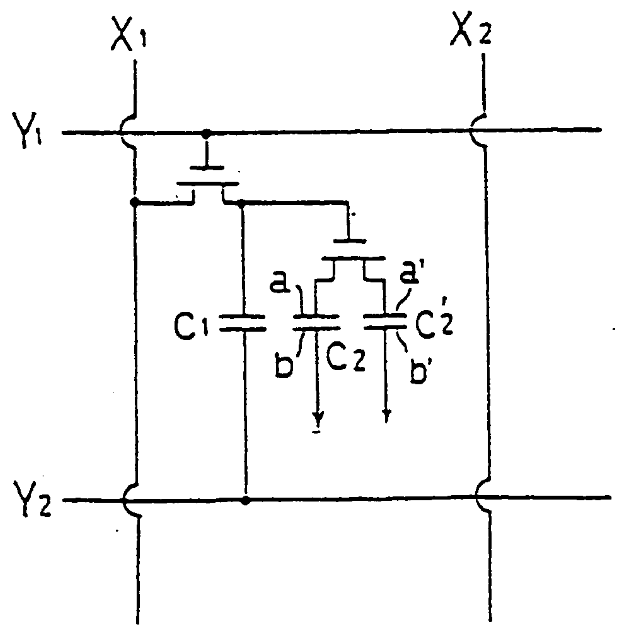


Fig. 2

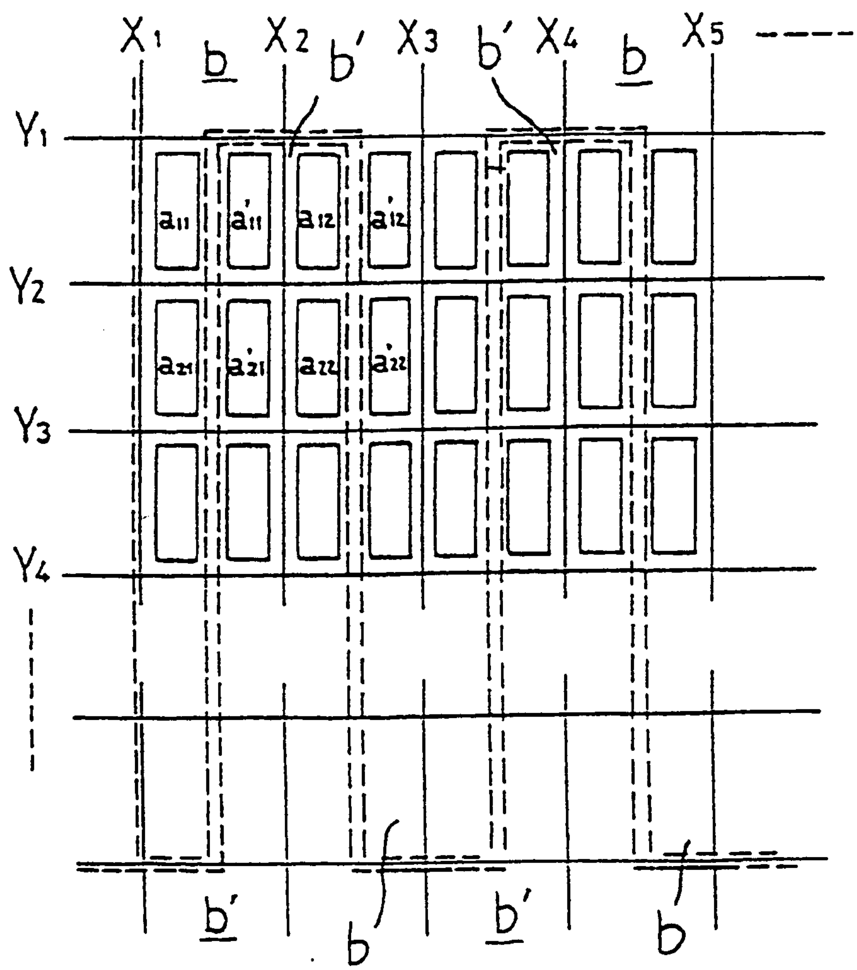

X1
b
X2
b'
X3
b'
X4
b
X5
Y1
Y2
Y3
Y4
a11
a'11
a12
a'12
a21
a'21
a22
a'22
b'
b
b'
b

Fig. 4

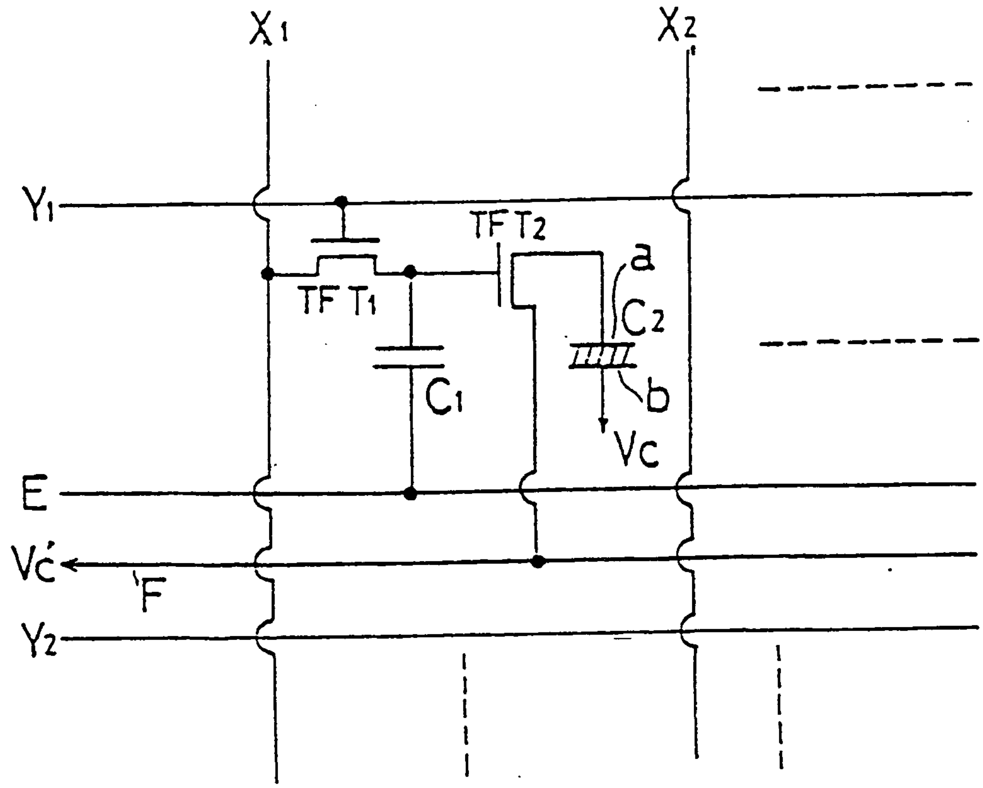


Fig. 5

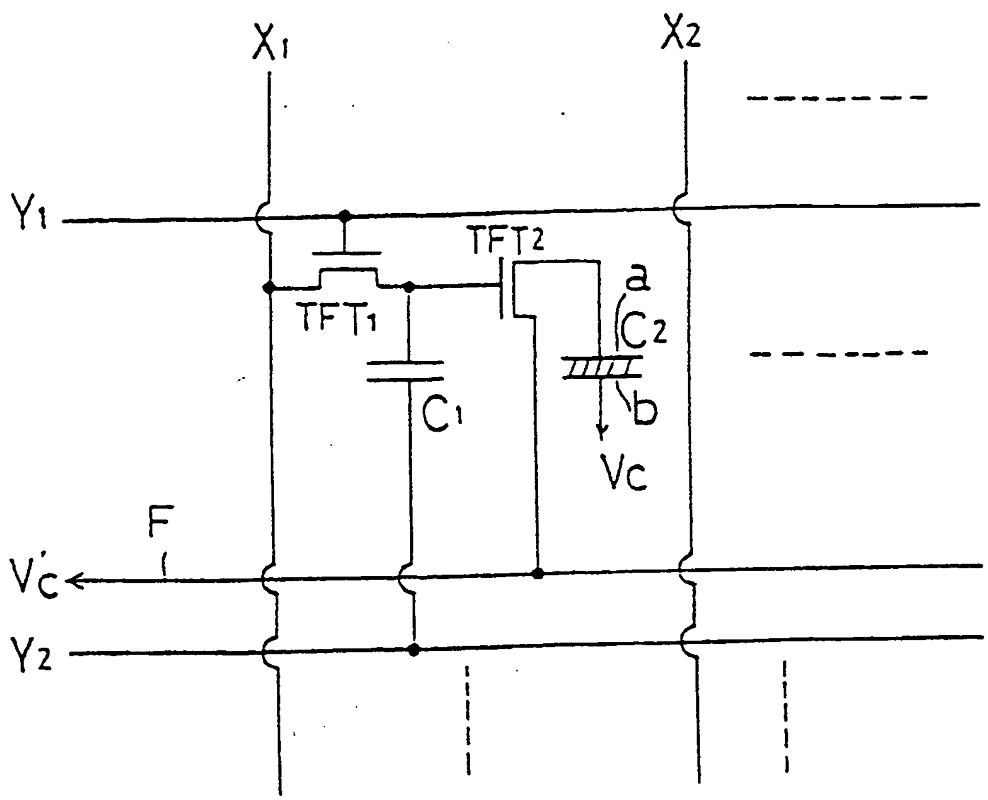


Fig. 6

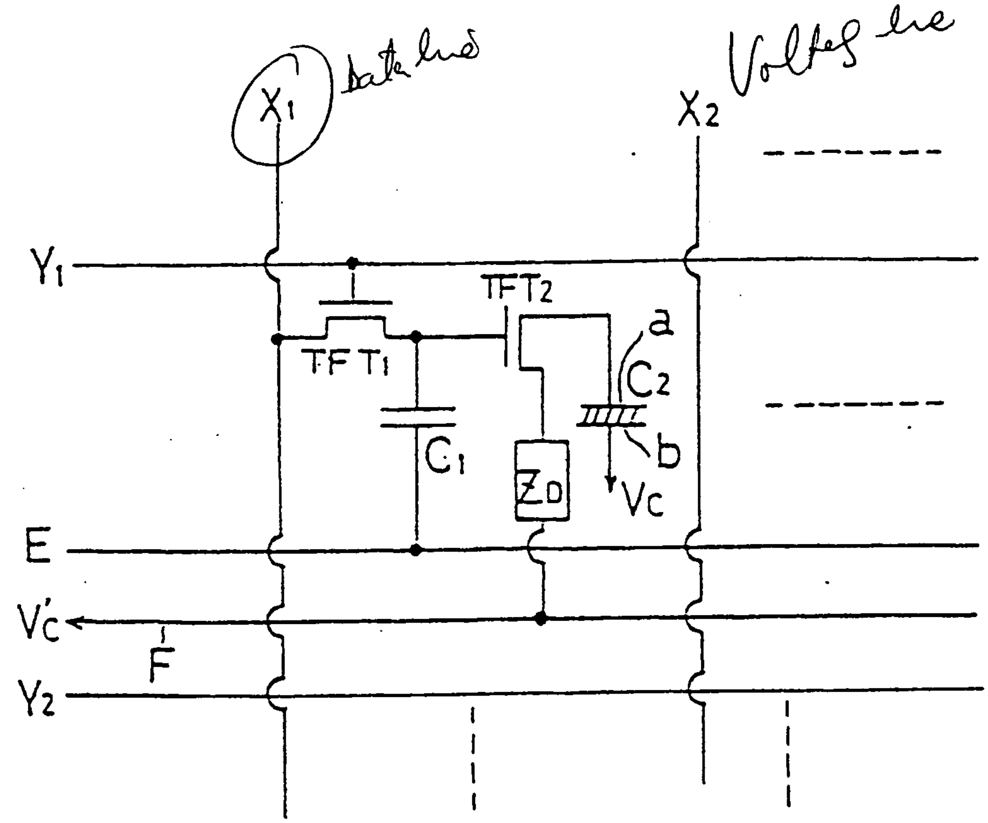


Fig. 7

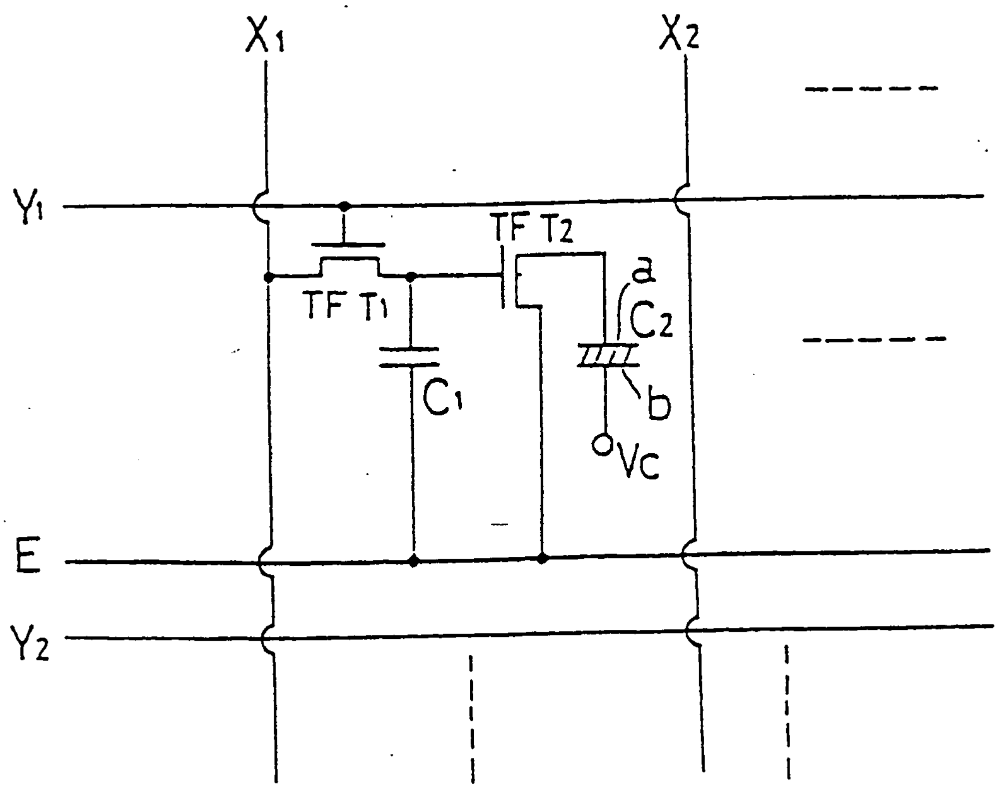


Fig. 8

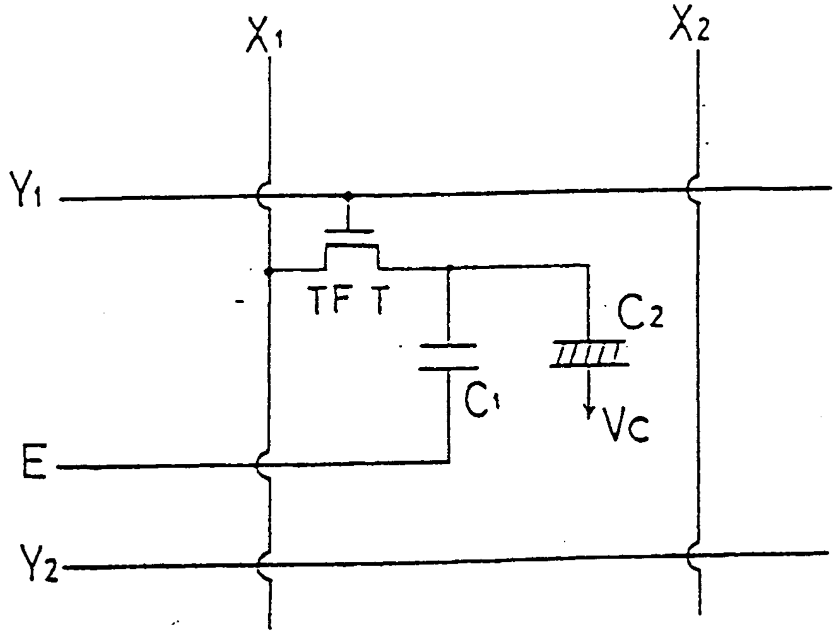
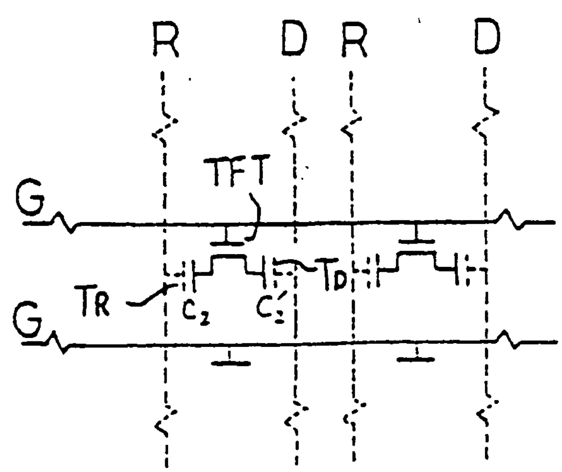


Fig. 9



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Application Number

EP 90 30 9124

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WO-A-8 502 931 (HUGHES AIRCRAFT CO.) * Page 6, line 5 - page 8, line 14; page 8, line 24 - page 10, line 28; claims; figures 2-4 *	1-2,4,7	G 09 G 3/36 G 02 F 1/136
A X	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 23, no. 8, January 1981, pages 3863-3864, New York, US; S.W. DEPP et al.: "Liquid crystal display driver circuit and polysilicon components therefor" * Whole document *	3 7	
A	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 24, no. 7B, December 1981, pages 3678-3680, New York, US; E.L. NEWMAN: "AC drive circuit for an integrated liquid crystal-silicon display" * Whole document *	5	
A	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 161 (P-370)[1884], 5th July 1985; & JP-A-60 37 527 (SHARP K.K.) 26-02-1985 * Abstract *	3	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN, vol. 13, no. 271 (P-889)[3619], 22nd June 1989; & JP-A-1 63 928 (HITACHI LTD) 09-03-1989 * Abstract *	3	G 09 G G 02 F
A	EP-A-0 086 349 (HITACHI LTD) * Figure 10 *		

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	28 November 90	IASEVOLI R.

CATEGORY OF CITED DOCUMENTS

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